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ABSTRACT

Theoretical frameworks are useful to developmental educators investigating the areas of grammar, critical reading, and the introductory physical science course. Of all available approaches to grammar, sector analysis proves the most powerful as a tool for developmental educators. It is designed to show how a few possible grammatical constructions, appearing within various sectors, shape the meaning of the sentence as a whole. As a tool for describing the varieties of constructions in various positions, it offers a precise diagnosis of student writing, in terms of both strengths and weaknesses. As for critical reading, a model based on recognition of patterns of content, language usage, and rhetorical devices--and their interaction--provides for diagnosis of students' abilities with such subskills as classification, pattern recognition, and inference. When teaching science, teachers must assure not only that developmental students perceive scientific phenomena in terms of the fundamental perceptual categories, but also that they are familiar with the "grammar" by which the measurements of those properties are interrelated in the derivation of more sophisticated concepts/properties. With such theoretical approaches, developmental educators can focus on specific materials and student behaviors within the various disciplines. Handouts illustrating points discussed are included. (HOD)

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INCREASING THE THEORETICAL BASE OF DEVELOPMENTAL EDUCATION: CASE STUDIES IN GRAMMAR, CRITICAL READING AND INTRODUCTORY SCIENCE

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INCREASING THE THEORETICAL BASE OF DEVELOPMENTAL EDUCATION: CASE STUDIES IN GRAMMAR, CRITICAL READING AND INTRODUCTORY SCIENCE

Daniel J. Kurland

To what degree do students demonstrate an understanding of the underlying structure of various disciplines? The question may seem a bit arcane, but it is of critical importance to developmental educators. Only by analyzing student behavior in terms of the conceptual frameworks of various disciplines can we truly speak of their competence in these disciplines and direct our instructional efforts accordingly.

The problem is, of course, far from simple. Indeed, what are the structures of the various disciplines? And to the extent that they are known, are developmental educators aware of the answers?

THEORY AND PRACTICE

The above concerns raise the broader question of the role of theory in developmental education. The notion of pedagogic theory is hardly new , especially at lower levels of education, yet in all too many cases such theory is either weak or limited, weak insofar as it is not specific to the differences between materials and tasks in the various disciplines, limited insofar as it is more often a philosophy of action than an analysis of the problems responsible for those actions. A cursory examination of teacher

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publications finds most articles of a "how to" nature, either in terms of general approaches to learning or accounts of specific teaching practices. Where such techniques are fruitful, well and good; why they work may seem irrelevant. And yet we might demand more both of ourselves and our discipline.

Knowing why a particular approach works can contribute to an understanding of possible improvements, extensions or the transferability of the method. But even more importantly, for those instances in which success is not immediately forthcoming, or in which present techniques are marginally effective, theory can be extremely valuable in shaping new approaches and practices. Theory can provide the insight for practice.

Theories intended to enlighten pedagogic practice must be closely allied with the real needs and materials of the academic curriculum. In addition, they must arise and be consistent with observations of student behavior. Theory must evolve from, and reflect, practice.

Within this framework, much analysis within the disciplines is little more than exercises in academic trivia, of interest solely to the philosopher of the discipline; it is neither intended for, nor useful to, developmental concerns.

On the other hand, seemingly theoretical questions about the structure of the disciplines can be of major importance for developmental educators. To teach writing, we must fully understand the structure of the sentence; to teach reading, we must have a practical theory of how meaning is extracted from or discovered within a text; to teach science we must have an understanding of the underlying language of scientific discussion, the

interrelationship of language, mathematics and observation within scientific discussion.

In the discussion that follows, the term "theory" is employed to refer to the perceptual framework by which a topic is investigated -- the descriptive categories and terminology employed and the interrelationships between such elements. Theory thus encompasses the analytic framework that shapes the perception of the subject matter -- in a sense, an articulation of all that is assumed, presumed, or implicit to a practitioner within the field.

Utilizing this notion of theory, the following discussion examines implications in the areas of grammar, critical reading and the introductory physical science course as examples of the need for and usefulness of theoretical frameworks designed by, and to meet the needs of, developmental educators. The first examples is based on the work of Robert L. Allen with whom the author studied; the latter two recount the author's own experiences.

GRAMMAR

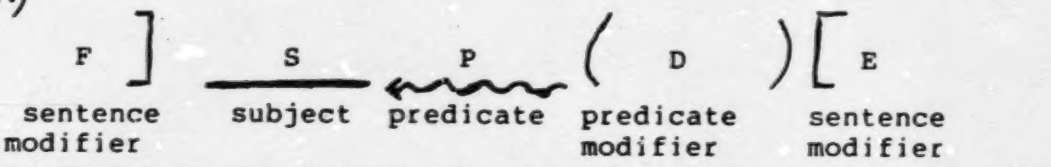
Ideally. a grammar should provide a useful tool for, among other things, diagnosing the range of student competency with the full resources of the language; describing not only what a sentence is, but the nature of commonly produced errors; explaining ambiguous sentences; relating the use of various grammatical constructions to differing levels of sophistication of expression; describing non-formal usage; explaining punctuation rules; and providing a base for the discussion of both reading and writing within a single theory.

Traditional prescriptive approaches to grammar fail on many if not most of these counts. More modern descriptive approaches, such as transformation grammar, are of major significance not in themselves but insofar as they document the possibility, and legitimacy, of alternative descriptions of the language. Of all available approaches, sector analysis, the creation of Dr. Robert Allen, proves the most powerful as a tool for developmental educators.[1]

Sector analysis is concerned with grammatical constructions as opposed to more traditional "word grammars." It is designed to show how a limited number of possible grammatical constructions, appearing within various sectors or slots, shape the meaning of the sentence as a whole.

Sector analysis views the sentence as composed of obligatory subject and predicate slots (S & P) plus two optional slots, a predicate modifier slot (D) following the predicate and sentence modifier slots (F & E) preceding and following the remainder of the sentence. (Constructions in the F and E slots are interchangeable without affecting the meaning of the sentence -- with slight styllistic restrictions on preferential placement.)

see 1B 2A



Robert L. Allen, English Grammars and English Grammar, New York: Scribners, 1972, o.p. Chapter IV,"An Intrroduction to Sector Analysis" is available in xerox form from Teahcers College Bookstore, 1224 Amsterdam Avenue, New York, NY 10027 for $6.10.

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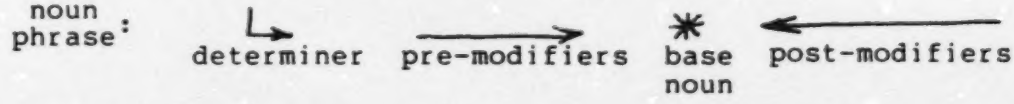
Each of the above positions is filled by a listable set of possible grammatical constructions, such as noun phrases, prepositional phrases, clauses, clausids, X words, etc. The F and E slots, for instance, are commonly filled by adverbs, prepositional phrases or clauses, in each case serving to restrict or otherwise qualify the assertion within the base S/P unit, generally in terms of place, condition or time.

see 1A 8-11

Each of the above mentioned constructions can be analyzed at lower levels of analysis. (While sector analysis does proceed to the word level, its power is at higher levels of analysis.) A noun phrase, for instance, a common filler of the S slot and a major constituent in prepositional phrases, is analyzed into a base noun plus pre- and post-modifiers:

see 1A 1-7



Pre-modifiers include determiners (words whose presence signify the beginning of a noun phrase, such as a, the, his, etc.) as well as adjectives (for which a distinct order is designated: size, color, material....etc.). While the pre-modifiers tend to be single words, the post-modifier position is filled with prepositional phrases or clauses (the latter described as "that-", "wh"-word, "-ed" and "ing" clauses).

Finally, in this decidedly simplified overview, various constructions can be placed as inserts at the interface of sectors or slots at all levels of analysis to produce increasingly complex sentence forms.

see 2B

Returning to the earlier list of the requirements of a grammar, the power of sector analsyis as a developmental tool becomes apparent. As a tool for describing the varieties of constructions in various positions, it offers a precise diagnostic tool for describing student output, both in terms of strengths and weaknesses. Insofar as most student-produced sentence fragments are legitimate grammatical constructions (albeit not sentences), the sector model enables students to recognize fragments for what they are rather than for what they are not, a far more feasible approach for self-editing. Possibly the most striking power of sector analysis is its use in delineating ambiguity, as in the following sentences:

He did not marry her (because he loved her) (They are married)

He did not marry her [because he loved her.] (They are not married).

The use of optional sentence positions (whether sentence modifiers or noun-phrase post-modifiers) to qualify a base sentence unit vividly demonstrates the role of more complex constructions to achieve more qualified or sophisicated thought. (Indeed, in many composition courses the difference between an A and a C paper can be tied to a student's use of the F position and noun-phrase post-modifiers). Sector is useful in the description of both foreign language interference (Yiddish commonly places the D sector at the beginning of the sentence) and in terms of non-standard dialect rules (as with Black English verb structures), and the notion of inserts provides a device for relating grammar and punctuation (other than for series commas, commas are used to bracket off inserts from the remainder of the sentence or, with certain stylistic constraints, to bracket sentence modifiers in the F position from the remainder of the sentence). Finally, sector analysis is an apt system for

describing the extent to which reading understanding is dependent upon grammatical decoding, a point seen dramatically in the earlier example of ambiguity.

The preceding discussion is not meant to suggest that teachers should teach sector analysis to their students; the concern here is to recognize sector analysis as an analytic and diagnostic tool enabling greater command of the students' written output. On the other hand, I do not wish to suggest that certain aspects should not be taught in individual instances. The author has used a sector-based sentence model with second grade children on the Hopi Indian reservation to help them dictate more extensive sentences by using a format

who / did what / how / when or where

As with any alternative grammar, the teaching of sector analysis involves the potential added confusion of an additional descriptive system and its concomitant terminology. And yet to the extent that sector analysis taps perceptions that are fundamental to developmental instruction and the inculcating of self-editing processes, it is a valuable tool to be employed as the occasion permits.

CRITICAL READING

With critical reading we again confront an area in which the traditional theory is severely limited, if not inadequate, for developmental purposes.

Most discussion of critical reading is devoted to the goal of a critical response to texts; little if any discussion is offered on how students are to achieve this level of response. Articles list the characteristics of a critical response and discuss how

teachers can manipulate discussion to test for critical repsonses, but none offer discussion of how the reader is to confront the page and manipulate elements of the text to achieve a critical understanding on one's own, or even in response to questioning. As a result, some commentators talk about the goals of reading between the lines or even of reading beyond the lines as though critical reading involved a process of perceiving something that is not on the page itself. Further, most discussion remains tied to false notions of a dichotamy between fact and opinion, between exposition and persuasion; they fail to discuss the opinion inherent in the selection of facts or the modes of persuasion present in the ways in which facts are presented. The myth of academic objectivity is never questioned. Critical reading thus is commonly associated with evaluative or judgmental reading rather than with a more open-ended investigation of the underlying perspective and meaning of the text itself.

A more useful approach to critical reading must account for how the reader obtains a critical understanding from the printed text. It must account for how the text is perceived, what one looks for, and how one manipulated what one finds. And as such, it must contain a theory of how meaning is encoded within a text, once again, a theory that has implications for both the encoding and decoding processes, reading and writing.

With these concerns in mind, I approached the task of developing a critical reading strategy from two fronts: an analysis of student discussion of texts and an analysis of non-fictional textual material itself. From the first I hoped to distinguish various levels of response that might indicate different ways of perceiving the text in the first place. I hoped then to correlate

these modes of response with an analysis of the interrelationship of elements within the text itself.

The initial investigation produced the observation that students tend to respond to texts at three levels of insight, each suggesting a different perception of the nature of the text and hence a different notion of the nature of reader accountability: 1) viewing the text as a source of authoritative information, accountability requires memorizing the information, resulting in restatement and paraphrase of the original assertions; 2) viewing the text as a source of significant opinion, accountability lies in recognizing how certain information is drawn together to support a conclusion, resulting in a description of the assertions and organization of the presentation; 3) viewing the text as a presentation of belief, accountability lies in detecting the asssumptions, perspective and biases inherent in the presentation of the topic, resulting in a critical examination of all aspects of the written presentation.* (One should note that any text can be read at any or all levels of reading just cited). Each level obviously requires an increasingly active, reflective reading behavior by the student. The next step was to determine the nature of that activity.

Daniel J. Kurland, "The Student's View of the Text: Implications for Reading and Writing," College Composition and Communication, December 1975.

To isolate how meaning is contained within a text, I examined how alterations of constituent elements resulted in changing meaning of the text as a whole. Contrary to expectations, it appeared that the meaning of a text resides less in the topic sentences than in the evidence, illustrations and examples offered in support or those assertions. When evidence contrary to topic sentences is present, the evidence prevails. (If a text states that someone is humane and offers evidence to the contrary, the later is ultimately convincing.) But the individual examples themselves do not provide the key either; any example of the same notion would suffice. It is not so much the examples themselves that control the meaning as what the examples are examples of, a classification controlled by patterns throughout the text.

The above analysis produced a model of critical reading based on the recognition of patterns of content, language usage and rhetorical devices and the interaction of these elements within the overall presentation. Such a model seemed consistent with the third stage of response to texts mentioned earlier. Critical reading is then a process, initiated by skepticism, based on the analysis of specific textual elements -- an active process of classifying the nature of patterns of elements throughout the text. As a final point, the theory establishes the notion of "thought-units," that the inference of meaning stems from the recognition of certain kinds of information

related in specific ways.

Such a theory, developed for non-fictional texts, can be expanded to encompass additional elements common to literary analysis as well as to materials within specific discipline courses. Above all, the theory accounts for the literal perspective short-circuiting most critical approaches to texts (critical approaches commonly observed when students confront either verbal material or written material about which a skeptical attitude is assumed to be legitimate, e.g. ads) and specifies activities that can be undertaken to improve critical understanding and response. Finally, the theory provides a basis for diagnosing the students' abilities with subskills such as classification (including the ability to form extended noun phrase labels), pattern recognition and inference.

SCIENCE

With science we once again confront the need for a reorientation of theoretical perspective for productive developmental instruction.

Science is typically presented in terms of major historical discoveries (e.g., the Gas Laws), "big ideas" (e.g., molecular theory) or the scientific method of investigation. As such, the discipline is presented in terms of an investigatory process and its discoveries rather than in terms of the

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descriptive language of scientific investigation and discussion, how the accumulated knowledge of the discipline is conceived and articulated.

In pursuit of the underlying conceptual framework of academic scientific discussion in the introductory physical science course, I undertook an analysis of the texts, lectures and problem sets and examinations of an introductory college chemistry course.* Initially, I focussed on the nature of standard problems, hoping that by isolating the skills necessary for academic problem solving I could tap the underlying linguistic/mathematical/perceptual language of science presentations.

This investigation led to a number of realizations: that most problems take the format "Given a series of measurements, provide a related measurement"; that such problems are solvable only if the relationship between the known and unknown measurements is itself known; and that such relationships are generally contained not in discovered laws but within the definitions of the properties under discussion. Notions of measurement seemed to play a critical role in scientific problem solving.

The recognition of the primacy of measurement concepts is reinforced in various other aspects of the course: academic

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Daniel J. Kurland, "The Nature of Scientific Discussion: Critical Reading and the Introductory Science Course, Journal of Reading, forthcoming.

physical science is essentially a discussion of measurements -- of what is to be measured, how it is to be measured, and the relationships between resulting measurements; scientific equations (e.g., F=ma) are not so much statements of the relationships of properties as statements of the relationships of measurements of those properties; the bulk of laboratory apparatus is devices for measurement -- balances, rulers, thermometers, etc.

The centrality of measurement can be seen in yet another way, one with specific bearing on the underlying perceptual framework of scientific discussion. Scientific properties -- force, color, acceleration, tensile strength -- are based on (defined in terms of) a limited number of fundamental properties -- time, mass, length, temperature and the mole (a unit of counting). Additional properties are then derived from these fundamental properties through the assertion of mathematical relationships. It is not that a natural-occuring property is discovered to be proportional to distance and inversely proportional to time (v=d/t), but that the construct velocity is so defined.

The above observations have a dual impact on developmental science teaching. Not only must we assure that students perceive scientific phenomena in terms of the fundamental perceptual categories, but we must assure that they are familiar with the "grammar" by which the measurements of those properties are interrelated in the derivation of more sophisticated concepts/ properties.

As to the fundamantal perceptual categories, the inability of students to analyze the motion of a pendulum or the phenomenon of flotation in terms of mass, time and length or volume may not be so much a question of intellectual development (as Piagetians insist) as a lack of initiation into the specific perceptual/linguistic system of scientific description as opposed to pseudo-scientific categories such as heft, smell or other sense-related concepts.

The latter concern, that of the grammar of the relationships, emphasizes the need to consider the role of mathematics within scientific discussion. Investigating this area further, one notes that most derived properties take the form: "So much of one property for a unit amount of another," a notion symbolized by the mathematical process of division. Investigating further, one notices three sub-groups: relationships involving two distinct properties, X/Y, with dimensions of time, area or volume as common denominators; relationships involving a single property, x/X, in which the numerator represents a portion of the measurement within the denominator; and proportional relationships mediated by a substance-specific constant, k, kX/Y. Throughout, the mathematical notion of proportionality appears as a central construct in the derivation of scientific concepts. While proportionality has received some discussion in terms of problem-solving abilities, its broader role in the construction of categories of physical description is not

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generally noted.

As in the earlier discussion of critical reading, it is necessary to weigh the above discussion of the nature of academic discussion with an observation of student behavior (not just student performance).

In most physical science courses, one is struck by the passive, literal-minded approach to scientific discussion. Students focus on memorizing definitions, formulae, and algorithms for problem solving rather than a more active, reflective and even playful grasp of the underlying system of scientific discussion. As noted earlier, the definition of velocity is perceived as defining a natural category rather than as an assertion subject to the same constraints as all other definitions, that it is a purposeful, arbitrary construct within a larger system of discussion. And yet this behavior mirrors the way in which science is generally presented in the classroom. As noted earlier, the response to factual presentations is a literal-minded restatement of such "truth." Only by approaching the system of scientific discussion as consisting of arbitrary constructs based on a particular perceptual system can we expect students to respond in a manner more consistent with the nature of science itself, as a purposeful system for conceptualizing sense-perceptions within mathematical relationships. Here, as in the discussion of critical reading, we must merge a new and more insightful understanding of the nature of the material within the course with a recognition of basic

see 7B

conceptual stumbling blocks to students' mastery of that material.

CONCLUSION

In all of the above areas a new theoretical outlook is required, one generated not for the further glorification of the discipline but that responds to the needs of developmental education, one based not on broad philosophic concerns but upon the academic materials and student behaviors of the academic courses themselves. If we are to expect students to be active, reflective practitioners, we must ourselves approach the materials of the various disciplines in manners that will allow and facilitate such attitudes and behaviors. As -- developmental educators, we must demystify, for student and teacher alike, the underlying structures of the disciplines, we must finds ways to articulate and make conscious the knowledge, perspectives, intuitions and concepts essential for mastery of the materials.

HANDOUTS

1A

0a The boy bought seven Coke.

0b The plastic red small bucket...

0c The boy with red hair will eat an apple.

0d She read the book on the holocaust. NOUN PHRASE

0e She read the book to her brother. INDIRECT OBJECT

0f She read the book (with her glasses.) PREDICATE ADVERBIAL

0g She read the book [in the afternoon. SENTENCE ADVERBIAL

1 The boy will eat an apple.

2 The boy with red hair will eat an apple.

3 The tall handsome boy ate an apple.

4 The boy with red hair on his head ate an apple.

5 The boy sleeping on the lawn ate an apple.

6 The boy's sleeping on the lawn was illegal.

7 The boy who I saw yesterday ate an apple.

8 Yesterday] the boy ate an apple.

9 In the morning] the boy ate an apple. SENTENCE ADVERBIALS

10 After he won the game] the boy ate an apple.

11 While riding his bike] the boy ate an apple.

1B

PREDICATE ADVERBIALS

12 The boy ate an apple (with a knife.) — D

13 The boy ate an apple (on a plate) (with a knife.) — → D

14 The boy ate an apple from Wisconsin (on a plate with a gold border.) — D

15 The boy left the apple for his brother. — IO

16 The boy considers apples vegetables. — C

17 The boy bought a gift for John from Mary (with Helen. — O IO C D

18 The boy saw an apple shining in the light. — C

19 The boy ate an apple with a worm. — C

20 The boy who is my brother ate an apple.

21 The boy, who is my brother, ate an apple.

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READING: Daniel J. Kurland, "The Student's View of the Text: Implications for Reading and Writing," College Composition and Communication, December 1975.

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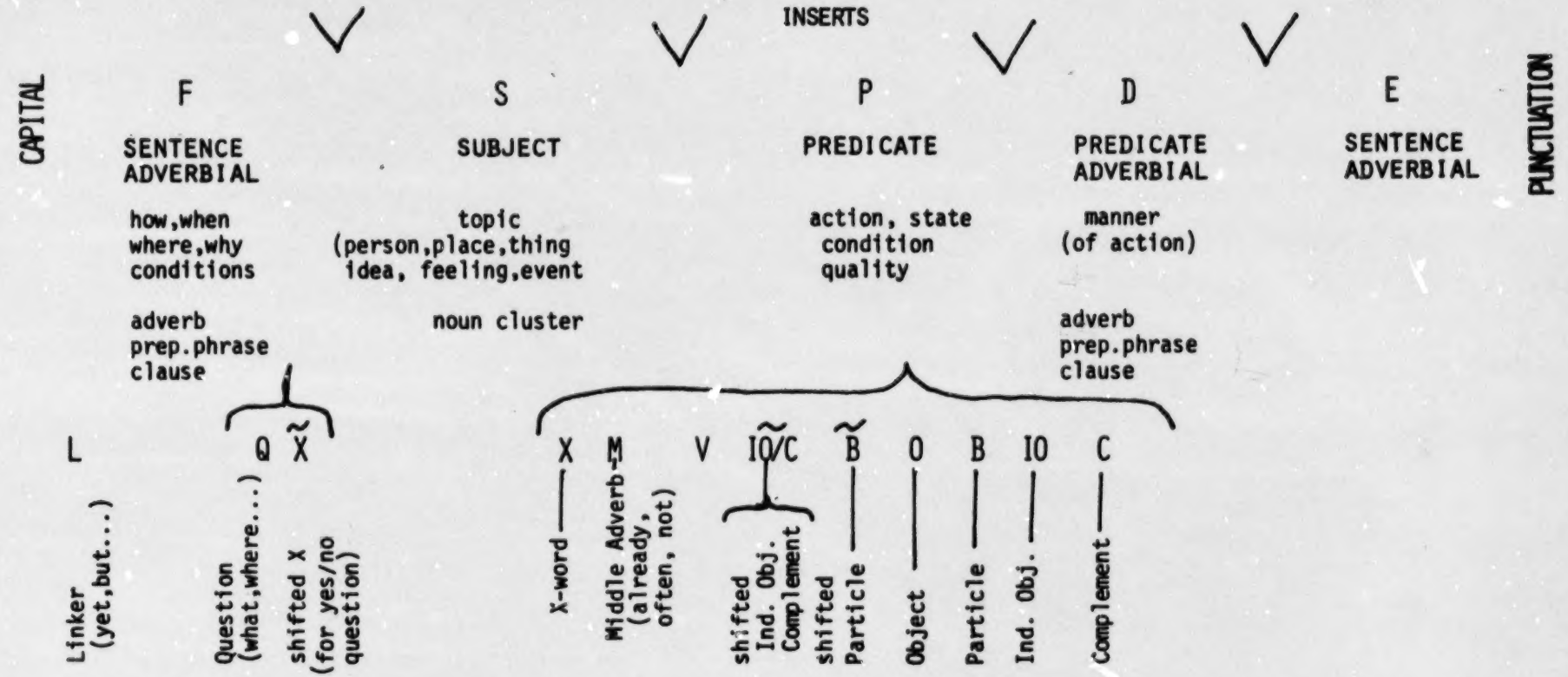
Daniel J. Kurland, "The Underprepared Student, Piaget and Scientific Literacy: Reflections on the Role of Measurement in Scientific Discussion," Journal of Chemical Education, Vol. 59, No. 7 (July 1982).



Sn: + capital + Sentence Unit + end punctuation

Ut: ± F + Trunk ± E

Tk: + Subject + Predicate

Pr: + X + Y

Y: +H ± D

CLUSTERS: {noun, adjective, adverbial} PHRASES: ⟨prepositional⟩ CLAUSES: [included= +I + Ut; clausid = +I + V] PREDICATES: (predicate= + X + Y; predicatid= + Y)

Lastly, I should not chuse this manner of writing, wherin knowing my self inferior to my self, led by the genial power of nature to another task, I have the use, as I may account it, but of my left hand. And though I shall be foolish in saying more to this purpose, yet since it will be such a folly as wisest men, going about to commit, have only confest and so committed, I ma, trust with more reason, because with more folly, to have courteous pardon.

Lastly, I should not chuse this manner of writing, ⟨wherin knowing my self inferior to my self, led by the genial power of nature to another task, I have the use, as I may account it, but of my left hand⟩$_1$ And ⟨though I shall be foolish in saying more to this purpose⟩$_2$ yet ⟨since it will be such a folly as wisest men, going about to commit, have only confest and so committed⟩$_3$ I may trust ⟨with more reason, because with more folly⟩$_4$ to have courteous pardon.

$\rangle_1$ {
- wherein ⟨knowing$_V$ my self$_O$ inferior$_C$ to my self⟩ — PREDICATID
- ⟨led$_V$ by the genial power$_{D_1}$ of nature$_{D_2}$ to another task⟩ — PREDICATID
- I have the use
- ⟨as/I may account it⟩ — INCLUDED CLAUSE
- but of my left hand

}

$\rangle_2$ though/I shall be foolish in saying more to this purpose — INCLUDED CLAUSE

$\rangle_3$ {
- since/it will be such folly as wisest men — INCLUDED CLAUSE
- ⟨going about to committ⟩
- have only confest and so committed

}

$\rangle_4$ with more reason because with more folly — PREPOSITIONAL PHRASE

[from "The Reason of Church-Government Urg'd Against Prelaty," John Milon, 1641]

4A

RESPONSES TO THE ASSIGNMENT "ANALYZE THE ESSAY"

FOR A PETITION OF GRIEVANCES BY THE INMATES OF THE TOMBS

The inmates of the Tombs are denied decent food and clothing. They are subjected to Kangaroo Courts and sham hearings. Prisoners are beaten and medical treatment is denied to them.

This essay is an organized list to show the injustices of the courts and the detention home. The first two paragraphs deal with the situation in the courts. The courts are termed "Kangaroo Courts" which is an unofficial group that acts as a court of law. It talks about the hearings as being unjust by using terms such as "sham hearing" and "so-called hearings." This all amounts to injustice.

This essay is not so much on the rights of inmates to receive fair treatment, better facilities, etc. as much as it is a declaration of manhood and the right to be acknowledged as men. The essay makes use of a list organization to present facts that are intended to shed light on the prison and the court system.

The main theme of the essay is the shocking archaic penal procedures which force human beings into total isolation from the rest of the human race. Beginning with the denial of an individual's constitutional rights to be judged innocent until proven guilt and building by greater degrees the essay concludes wth the complete annihilation of human dignity. It appeals to the society it no longer is part of to protect their interests.

4B

THREE LEVELS OF READING/WRITING

	MODEL OF TEXT	VIEW OF THE TEXT	FORM OF DISCUSSION	UNIT OF INVESTIGATION	TOPIC OF DISCUSSION	PURPOSE
I	Window on World	Factual Information	Restatement	Literal Sentence Meaning	Subjects of Sentences	Memorize Information
II	Author as Objective Transmitter	Informed Opinion	Description	Separate Paragraphs/ Sequential	Subject of Topic Sentences	Follow Line of Argument
III	Author's Perceptions of World	Personal Belief	Interpretation	Patterns of Textual Elements Throughout	Underlying Concern	Discover Underlying Meaning

Mary had a little lamb,
It's fleece was white as snow,
And everywhere that Mary went
The lamb was sure to go.

RESPONSES TO "Mary had a little lamb"

RESTATEMENT: A girl named Mary had a little white lamb that followed her wherever she went.

DESCRIPTION: The poem tells about a girl named Mary and her lamb. It describes the lamb as soft and white and depicts it as following Mary wherever she went.

INTERPRETATION: The idea of innocent devotion is presented through a story about an animals' constant companionship with its mistress. The suggestion of innocence is conveyed by the example of a lamb, a timid animal, and a description that emphasizes its smallness, softness and cleanliness. The idea of devotion is conveyed through a description that emphasizes the regularity of the lamb's companionship suggested by terms such as "everywhere" and "sure" to go.

ALTERNATIVE 1

Physical properties (e.g., density, surface tension) are natural categories discovered by scientists. There is only one way to describe the physical universe, and science is the discovery of that way.

ALTERNATIVE 2

* All definitions are human assertions of particular notions/conceptual categories to fill some descriptive/explanatory need.
* All definitions describe a new item in terms of previously defined items within a general system of categories.
* Definitions of physical properties are constructed within particular mathematical forms, e.g. x/X, X/Y
* Definitions are more assertions of how something is to be measured than what it "is" conceptually or imagistically.
* Definitions of physical properties are essentially circular; given all but one measurement in the equation the remaining measurement can be computed.
* Definitions not only assert the related properties, but, by omission, properties that are independent of the one in question.
* All definitions may have limiting conditions

That is, definitions of physical properties are man-made, purposeful, and reflect a particular perceptual/conceptual framework for describing the physical universe. Science does not explain; it merely describes.